

CASE STUDY

CO₂ Quality Control in food and beverage industry.

Scope

There are different modes of CO₂ production frequently used in foods and beverages industry. Carbon dioxide is a by-product of many different natural and chemical processing mechanisms. This capability of multiple source types makes it unique in the industrial gas market.

The variation of sources results in a variety of specific impurities that may be anticipated to be present in carbon dioxide.

Specific organisms provides recommendations for good practice in order to provide guidance on the key characteristics for the quality and purity of carbon dioxide for use in foods and beverages:

- Compressed Gas Association of America (CGA)
www.cganet.com
- International Society of Beverage Technologists (ISBT)
www.bevtech.org
- European Industries Gases Associations (EIGA)
www.eiga.be

Required Analytical specifications

Analytical method mainly used to prove compliance with the specification is gas chromatography for this parameters:

Component	Concentration
Acetaldehyde	0,2 ppm v/v max.
Benzene	0,02 ppm v/v max.
Total sulphur (as S) *	0,1 ppm v/v max.
* if the total sulphur content exceeds 0,1 ppm v/v as sulphur then the species must be determined separately and the following limits apply :	
Carbonyl Sulphide	0,1 ppm v/v max.
Hydrogen Sulphide	0,1 ppm v/v max.
Sulphur dioxide	1,0 ppm v/v max.

source : CGA/EIGA limiting characteristics commodity specification for carbon dioxide from "carbon dioxide source certification, quality standards and verification", IGC Doc 70/99/E

Specifications and sample presentation

Carbon dioxide is a colourless, odourless and non combustible gas.

Carbon dioxide above the triple point temperature of $-56,6^{\circ}\text{C}$ and below the critical point temperature of $31,1^{\circ}\text{C}$ can exist in both a gaseous and liquid state. Bulk liquid carbon dioxide is commonly maintained as a refrigerated liquid and vapour at pressures between 1230 kPa (appro. 12 bar) and 2557 kPa (appro. 25 bar).

The sample shall be taken from the liquid phase of the bulk storage tank or from the liquid carbon dioxide product stream from the production plant.

Toxicity

Carbon dioxide content in fresh air varies between 0.03% (300 ppm) and 0.06% (600 ppm), depending on the location. It is dangerous when inhaled in high concentrations (greater than 5% by volume, or 50,000 ppm). The current threshold limit value (TLV) or maximum level that is considered safe for healthy adults for an eight-hour work day is 0.5% (5,000 ppm). The maximum safe level for infants, children, the elderly and individuals with cardio-pulmonary health issues is significantly less.

Dedicated analytical solution

The CO₂ analytical system is an integrated air conditioned cabinet made from different module:

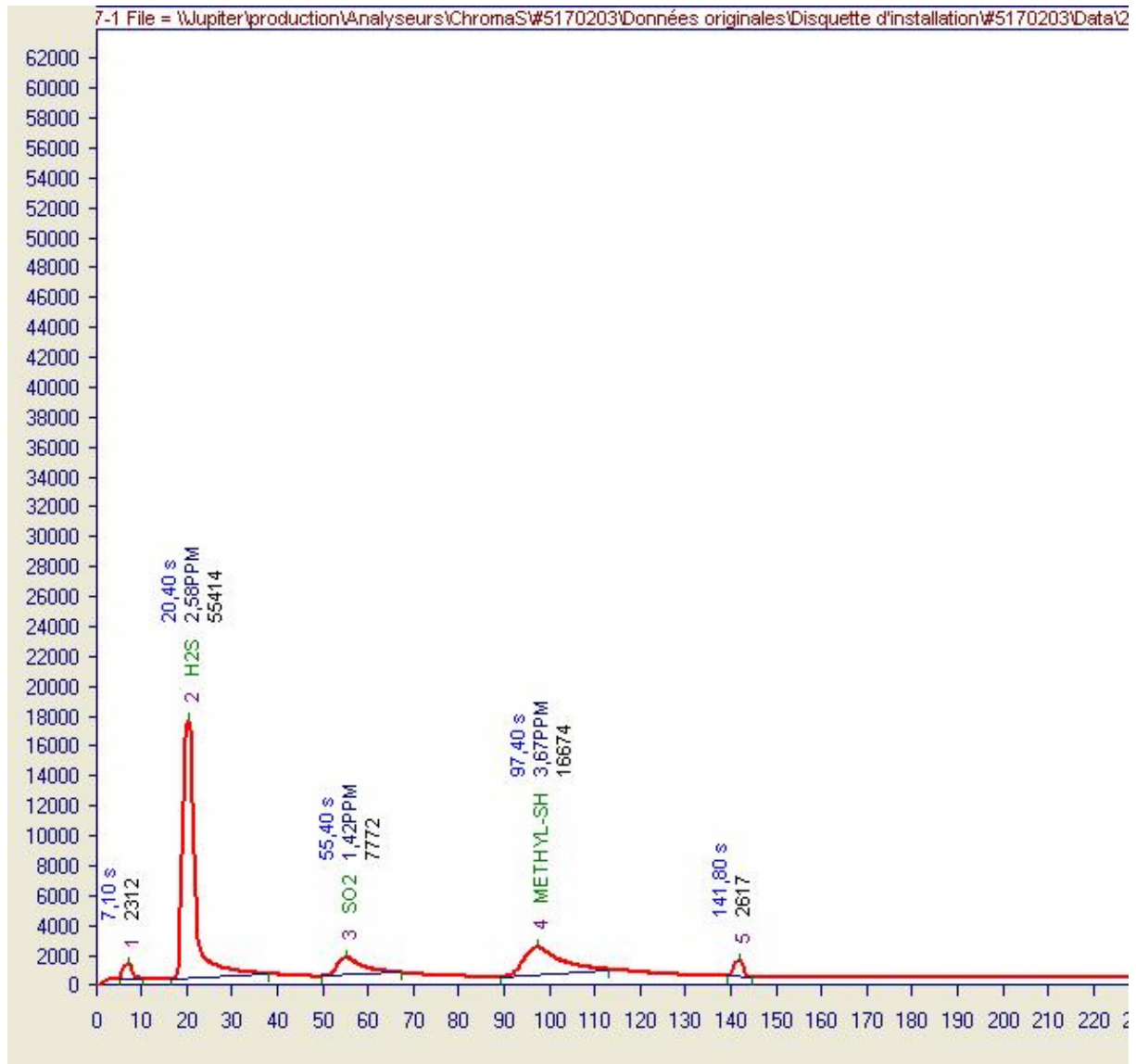
- C51000 - Chroma S: 4U module for Total Sulfur analysis: we analyse separately H₂S, mercaptans, DMS, DMDS, COS, CS₂ and SO₂ with FPD (dual Flame Photometric Detector). There is no quenching with the double flame.
- A34022 – airmoBTX : 4U module for acetaldehyde and BTEX analysis with FID (Flame Ionisation Detector)
>>>> airmoBTX FID : TÜV approved for <50ppt analysis
- XXX015 – supervisor : industrial computer 5U module , LCD display, Vistachrom software integrated for :
 - monitoring the analytical system
 - data acquisition
 - traceability with time-stamped results
 - transfert of result
 - trend function
- XXX916 – hydroxychrom : hydrogen generator 3U module
- XXX031 – airmopure : high quality air generator, 45 psi (3bar) compressor, catalyst system and filters
- XXX901 – airmopump : sampling pump
- XXX043 – installation in IP55 cabinet
- XXX931 – internal calibration module based on permeation tube (benzene or Di-Methyl Sulphide, DMS)

Application

Sulphur analysis:

Sulphur analysis (#5170203)	
cycle time	420 seconds
amplification	low (1)
loop	250 µl
quantification limit (H ₂ S)	< 10 ppb

Sample : H₂S, SO₂ , and Me-SH (+/- 20%)



Acetaldehyde and BTEX analysis:

Acetaldehyde and BTX analysis (#2200500)	
cycle time	1200 seconds
amplification	high (3)
trap	3 phases
acetaldehyde quantification limit	< 5 ppb
BTEX quantification limit	< 0,1 ppb

Substance table:

The permeation tube, swept by a constant stream of pure air or N₂ is installed in an oven regulated in temperature (+/- 0.1°C) inside the analyser and delivers a constant concentration of standard.

This feature allows validating all the analysis.

In this case the benzene is used, the others compounds are calculated with response factor.

#	Name	Rt Min	Rt Max	Alarm Min	Alarm Max	Factor	Def	Area off	Stand	fitmode	NofM
1	ACETALDEHYDE	80	90	0	9999	1,84	0	0	0	2	1
2	BENZENE	250	265	0	9999	1	0	0	0	2	1
3	TOLUENE	350	370	0	9999	1,05	0	0	0	2	1
4	ETHYLBENZENE	441	451	0	9999	1,10	0	0	0	0	1
5	M&P-XYLENES	447	457	0	9999	1,10	0	0	0	0	1
6	O-XYLENE	470	490	0	9999	1,10	0	0	0	2	1

Peak list

Substance	Result	Unit	Start	R.Time	Max	Stop	Area	Type
ACETALDEHYD	63,48	PPB	79,05	84,55	3634,00	94,50	11328,00	ST_E
BENZENE	7,91	PPB	250,60	260,65	2320,00	266,95	4604,70	ST_E
TOLUENE	5,69	PPB	358,00	362,70	2164,00	367,85	3489,20	ST_E
ETHYLBENZEN	6,16	PPB	440,70	448,20	2406,00	451,80	3866,80	ST_E
M,P-XYLENES	11,87	PPB	451,80	455,45	2818,00	460,90	5337,00	ST_E
O-XYLENE	10,19	PPB	474,60	479,85	2780,00	485,85	5886,10	ST_E

24 hours acetaldehyde analysis in continuous , Relative Standard Deviation:

< 0,3% over 48H (on retention time)

< 2% over 48H (on concentration)

Conclusion

Chromatotec is a group of companies specialized in the manufacturing and sales of gas analyzers. We offer a full range of automated and continuous analyser by gas chromatography focused in on-line analysis of Volatils Organics Compounds and sulfur compounds.

The CO₂ quality control application is very important for human health in food and beverage industry. We have a complete package and experience in this type of sample matrix with different module depending of the compounds to be analysed.

For result validation and long term stability, we propose an internal calibration system with permeation tube.

A specific function in Vistachrom software allows to monitor this auto-calibration.